Before the
FEDERAL COMMUNICATIONS COMMISSION
WASHINGTON, D.C. 20554

In the Matter of	)	
	)	
Petition to Modify Parts 2 and 101	)	RM-11809
of the Commission's Rules to Enable Timely	)	
Deployment of Fixed Stratospheric-Based	)	
Communications Services in the 21.5-23.6, 25.25-	)	
27.5, 71-76, and 81-86 GHz Bands	)	

SUMMARY

The extensive analysis conducted by Elefante Group in association with Lockheed Martin Corporation makes a promising case for deployment of stratospheric platforms (STRAPS). Nonetheless, further studies can be undertaken to ensure coordination criteria with incumbent services and future deployment use cases such as those under consideration in *Third Report and Order (3rd R&O)*, are optimized. With increasing demand for spectrum and wider bandwidth requirements for applications using mmWave communications, it is broadly acknowledged by the community that spectrum sharing and coordination is imperative. This document outlines considerations for coexistence of Stratospheric-Based Communications Services (SBCS) and 5G.

I. INTRODUCTION

SRS Technical Consulting LLC is a technical consulting firm headed by the author, Sahana Raghunandan. Sahana Raghunandan is an independent consultant and researcher with industry experience covering many aspects of satellite communications and networking, including waveform design, interference analysis, adaptive channel access schemes and cross-layer performance optimization. She is also a Ph.D. candidate in Electrical Engineering at Virginia Polytechnic and State University under Dr. Jeffrey Reed, wherein her area of research is

coexistence of 5G, satellite and airborne communication networks. Please note that the views expressed in these comments are entirely her own.

II. RELATED WORK

The term STRAPS introduced by Elefante Group is closely akin to High Altitude Platforms (HAPS) defined in ITU with the difference being the nominal operational altitude. ITU's definition refers to a "*station located at an altitude of 20 to 50 km and at a specified, nominal fixed point relative to the Earth*" while STRAPS is expected to operate at a nominal altitude of 19.8 km, but could rise to a maximum altitude of 21.3 km as indicated in the system parameters in Appendix A of the petition. As outlined in prior studies[1,2], stratospheric based platform designs date back to early 20th century with successful design and testing of more recent lightweight prototypes rendering it a viable platform for providing broadband data connectivity, remote sensing and other applications. These platforms may include (manned or unmanned) aircrafts, airships and balloons used for either military or civilian purposes[1,2]. Regulatory studies[3] on HAPS have been conducted previously including feasibility of interference mitigation techniques to enable coexistence with other services. Successful demonstrations for emergency and rescue operations using STRAPS-like platform has been recently demonstrated by KT[4]. Considering the state-of-the-art of these stratospheric based platforms, it may be

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[1] S. Karapantazis and F. Pavlidou, "Broadband communications via high-altitude platforms: A survey," in *IEEE Communications Surveys & Tutorials*, vol. 7, no. 1, pp. 2-31, First Qtr. 2005.
[2] d'Oliveira, Flavio Araripe, Melo, Francisco Cristovão Lourenço de, & Devezas, Tessaleno Campos. (2016). High-Altitude Platforms — Present Situation and Technology Trends. *Journal of Aerospace Technology and Management*, *8*(3), 249-262.
[3] J. M. Park, B. J. Ku and D. S. Oh, "Technical and Regulatory Studies on HAPS," *2008 IEEE Globecom Workshops*, New Orleans, LO, 2008, pp. 1-5.
[4] KT Unveils 5G Emergency Rescue Platform 'SKYSHIP', July 5, 2018, *https://www.prnewswire.com/news-releases/kt-unveils-5g-emergency-rescue-platform-skyship-300676490.html*

beneficial for the Commission to set up an inquiry to invite further comments from other manufacturers and operators.

III. STRAPS AND AERONAUTICAL MOBILE SERVICES

As deatiled in Appendices E, I, N and P of the petition by Elefante Group, Aeronautical Mobile Services (AMS) can coexist in the same frequency band even with the ground data terminal (GDT) operating at a minimum elevation angle of 3°. On the other hand, considering the large Field-of-View of the wideband AMS terminals, the minimum coupling loss (MCL) calculations can result in larger separation distance requirements from 5G Base Stations (BS) and User Terminals (UT) . With the introduction of STRAPS and beamforming capabilities of Aeronautical Data Terminals (ADT) , one viable approach to ensure compatibility of AMS with 5G is to use STRAPS as a relay to avoid interference to 5G BS and UTs. Within the context of application of HAPS, this concept of a relay has been explored previously for use cases such as airborne internet[5] , air traffic control[6] and extending the range for maritime services.

IV. STRAPS AND 5G

As elaborated in the petition by Elefante Group, SBCS can be an asset in the deployment of 5G services in the United States while serving to extend broadband connectivity to remote areas in the long term with low-latency, high-throughput communication links on par with the projected Quality of Service (QoS) values of 5G services. The STRAPS with flexible beamforming antennas can reorient the user beams to provide coverage over portions of metropolitan areas that experience 5G service outages or require additional bandwidth to fulfill

[5] Medina, D., & Hoffmann, F. (2011). The airborne internet. In *Future Aeronautical Communications*. InTech.

[6] Büchter, Kai-Daniel & Reinhold, A & Stenz, G & Sizmann Bauhaus, A. (2012).Drivers and Elements of Future Airborne Communication Networks.

different types of applications including data gathering from Internet of Things (IoT)-type devices. This would most certainly necessitate a detailed compatibility study with wideband and narrowband STRAPS terminals to characterize nominal interference levels and optimize the coordination zones with 5G BS and UTs in the overlapping frequency bands. The use of an integrated platform capable of communicating with both STRAPS and BS, may be beneficial in implementing interference avoidance and excision techniques.

Additionally, the proposed reuse of terrestrial infrastructure for low-altitude airborne platforms for surveillance or last-mile delivery may in some scenarios necessitate the BS antennas to operate with a beam uptilt instead of the nominal 10° downtilt. This can result in increased interference levels at Fixed Satellite Service (FSS) satellites. The use of STRAPS in such cases can instead provide an alternate relay path for control and acquisition of data from such low-altitude airborne platforms.

According to ongoing studies at ITU[7], HAPS UT and 5G BS/UT could require varying amounts of geographic separation, ranging from 200 m to a few km, depending on transmit power levels and minimum elevation angle requirements. The MCL analysis represents the worst-case scenario without specific HAPS antenna patterns, clutter and terrain considerations. All these additional system parameters along with the power control mechanism employed at the HAPS UT can reduce the necessary separation distance. To this effect, it will be beneficial to obtain more details about the type of analysis and scenarios considered by Elefante Group in the initial assessment of compatibility of STRAPS UT and 5G as mentioned in footnote *98* in the petition.

[7] ITU, Working Party 5C Report (prepared for new recommendation ITU-R F.[BROADBAND HAPS CHARACTERISTICS])

Interference mitigation techniques in earlier studies[3] have alluded to increasing the minimum elevation angle, dynamic traffic and channel assignment and power control to foster coexistence of different services. There is sufficient scope here to research the feasibility and application of site shielding, unilateral interference mitigation strategies such as antenna array beamforming[8] to reduce coordination distances and shrink the exclusion zones.

V. CONCLUSION

The operation of SBCS in the proposed frequency bands need not impede the deployment of future 5G services and can potentially provide a means by which AMS can also be rendered compatible. Additional studies can be conducted to examine the spatio-temporal characteristics of interference with terrain specific propagation models.

Respectfully submitted,

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[8] W. Roh et al., "Millimeter-wave beamforming as an enabling technology for 5G cellular communications: Theoretical feasibility and prototype results", *IEEE Commun. Mag.*, vol. 52, no. 2, pp. 106-113, Feb. 2014.

CERTIFICATE OF SERVICE

I, Sahana Raghunandan, hereby certify that on this 11th day of July, 2018, copies of the foregoing Comments of SRS Technical Consulting LLC were served by first-class U.S. mail, postage prepaid, upon:

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